

GEE5303 Green and Intelligent Building

<http://ibse.hk/GEE5303/>



Green building design strategies

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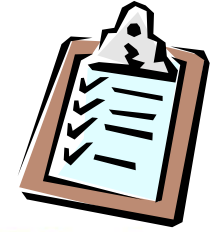
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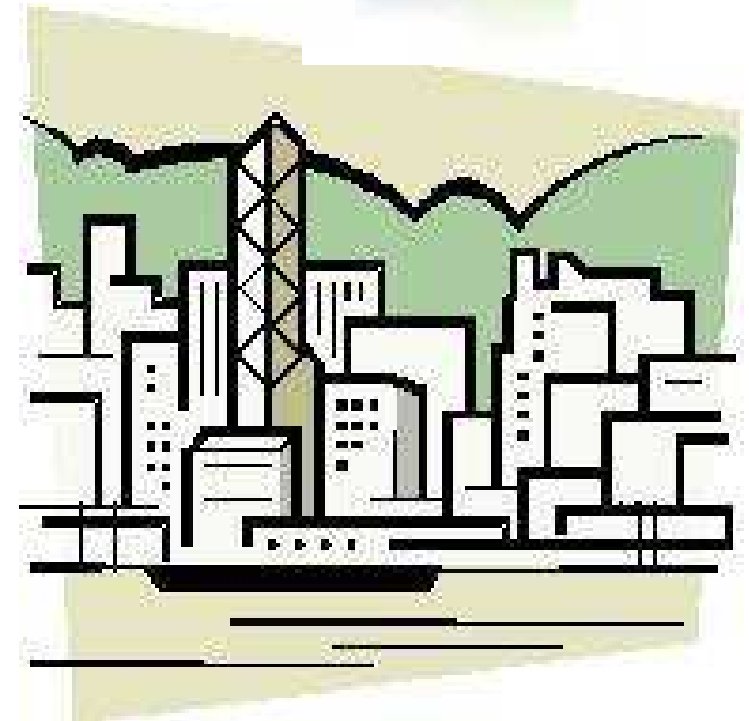
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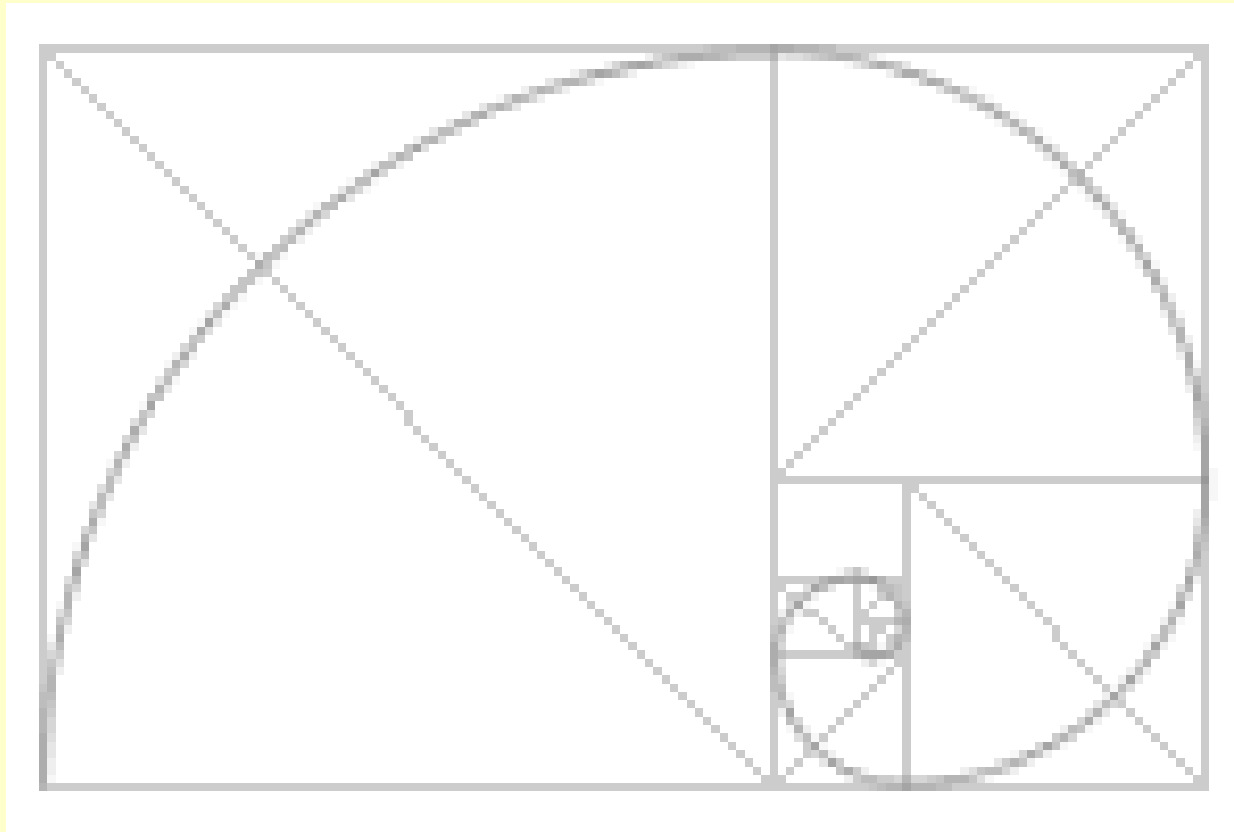
Jul 2017

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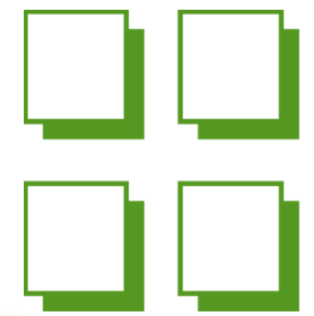


- Design strategies:
 - Urban and site design
 - Energy efficiency
 - Renewable energy
 - Building materials
 - Water issues
 - Indoor environment
 - Integrated building design





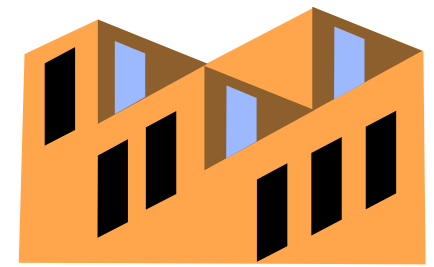
Design Strategies



Design strategies

- Sustainable site
 - Site selection, landscaping, building placement
- Energy and atmosphere
 - Energy sources, mechanical systems and controls
- Water efficiency
- Materials and resources
 - Design, material selection
- Indoor environmental quality

Urban and site design



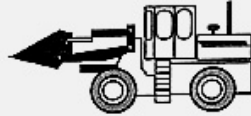
- Sustainable urban design should consider:
 - Spatial form
 - Movement
 - Design & development
 - Energy
 - Ecology
 - Environmental management
- Goal: to create livable cities





SPATIAL FORM

- ◆ Reduce / reverse decentralisation
- ◆ Increase densities but not excessively to encourage compact forms (neither cramming nor sprawl)
 - ◆ Increase appeal of inner areas (greening, defensible space, housing type, etc.)
 - ◆ Encourage mixed-use developments
- ◆ Density related to nodal points / public transport
- ◆ Relate to existing infrastructure (utilities and roads)
- ◆ Develop brown field sites and avoid green field sites
- ◆ Relate built and natural environments (open space provision, green space networks, etc.)
 - ◆ New settlements to be self sustaining
 - ◆ Assess environmental capacity



ENVIRONMENTAL MANAGEMENT

- ◆ Co-ordinate statutory authorities
- ◆ Encourage urban management (support cleanliness)
 - ◆ Reduce pollution and polluted sites
- ◆ Re-educate professionals, public and politicians
- ◆ Economy of means as the overriding goal



MOVEMENT

- ◆ Reduce the need for travel
- ◆ Design for pedestrianisation / environmentally friendly transport
 - ◆ Recover road space for public use or public transport
 - ◆ Exclude non-essential traffic
 - ◆ Minimise car parking
- ◆ Encourage route connectivity and permeability
 - ◆ Tame traffic flows

SUSTAINABLE URBAN DESIGN



ECOLOGY

- ◆ Assess ecological value of sites and encourage continuity
- ◆ Protect natural assets and preserve landscape (individuality)
 - ◆ Maximise bio-diversity
 - ◆ Increase rainwater retention (tree planting)
- ◆ Reduce run-off (permeable paving, natural channels)
 - ◆ Preserve individuality of landscape character
 - ◆ Green towns and cities



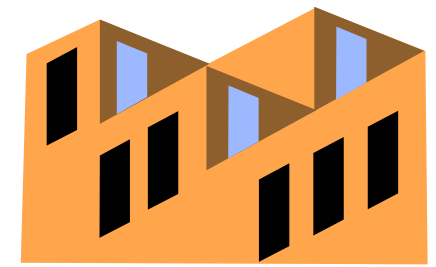
DESIGN & DEVELOPMENT

- ◆ Rehabilitation rather than redevelopment
 - ◆ Recycling of materials
 - ◆ Use local materials
- ◆ Environmentally friendly materials / techniques
 - ◆ Protection of built heritage
- ◆ Show openness to sustainable architectural forms
- ◆ Recommend BREEAM and NHER procedures
 - ◆ Encourage robust building forms (adaptable and resilient)
- ◆ Visual quality and appropriateness
 - ◆ Preserve local distinctiveness



ENERGY

- ◆ Passive solar gain (orientation, design, layout)
- ◆ Renewable energy sources (solar, hydro, wind)
 - ◆ Accept responsive facades
 - ◆ Encourage energy conservation
- ◆ Microclimate (discourage development on exposed sites and use natural features)
 - ◆ Encourage use of natural daylight
 - ◆ Discourage air-conditioning and encourage natural ventilation



Urban and site design

- Design issues:
 - Site selection (e.g. prefer brownfield site*)
 - Promote efficient movement network & transport
 - Control & reduce noise impacts
 - Optimise natural lighting & ventilation
 - Design for green space & landscape
 - Minimise disturbance to natural ecosystems
 - Enhance community values

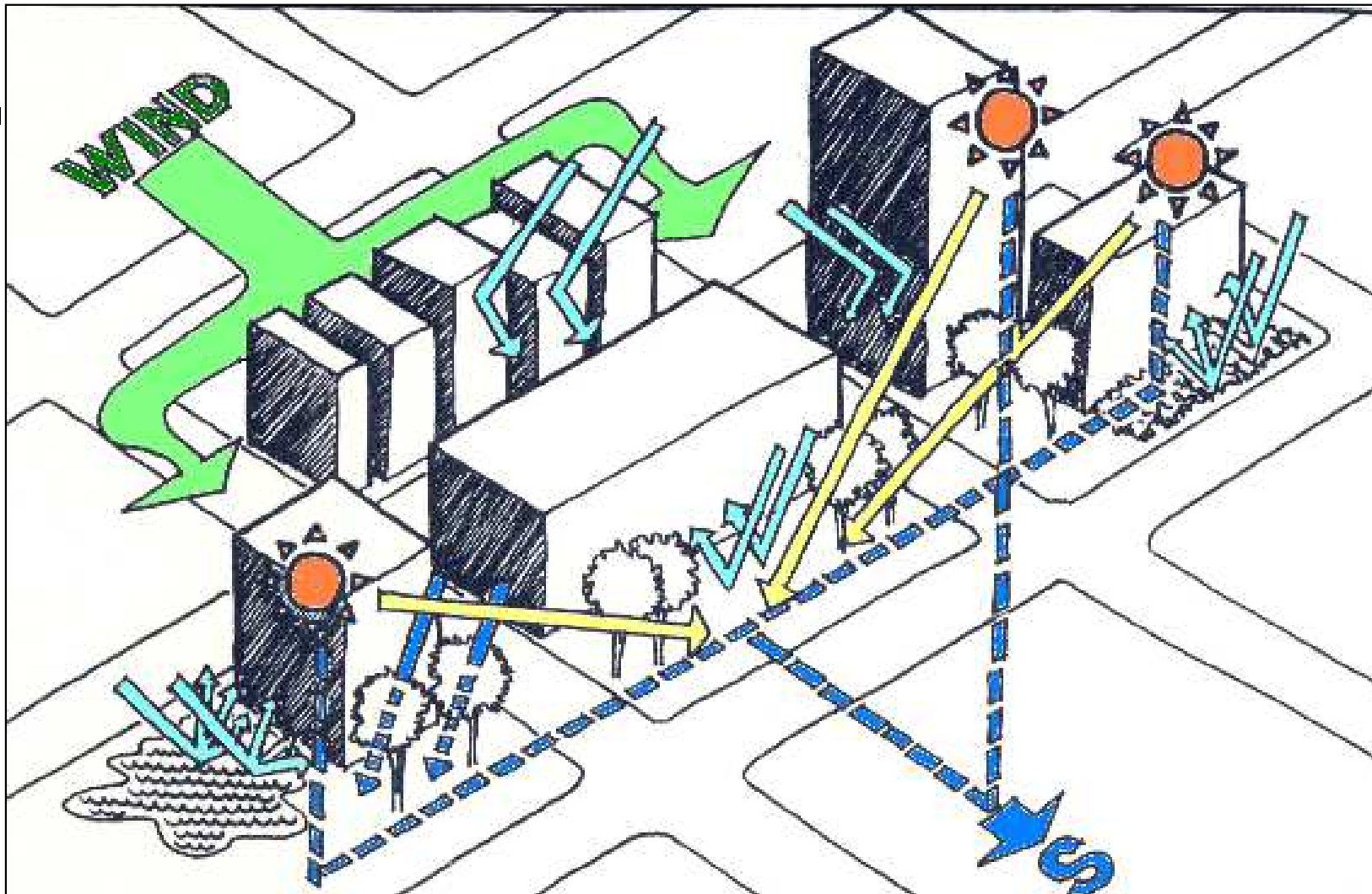
[* Brownfield sites are abandoned or underused industrial and commercial facilities available for re-use.]

風

Wind

光

Light



水

Water

物

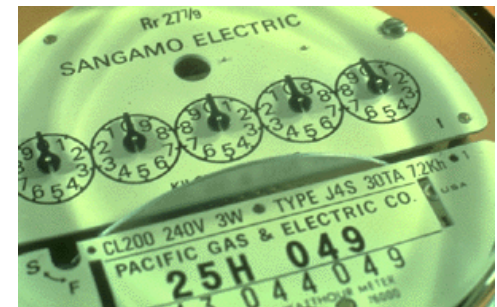
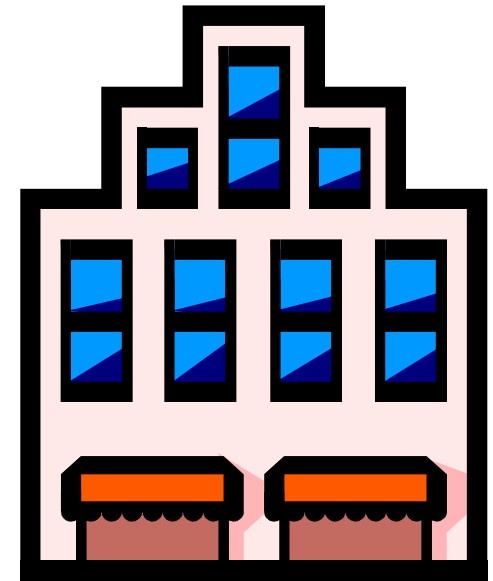
Matter

Site analysis and understanding of the environmental factors is important

Energy efficiency



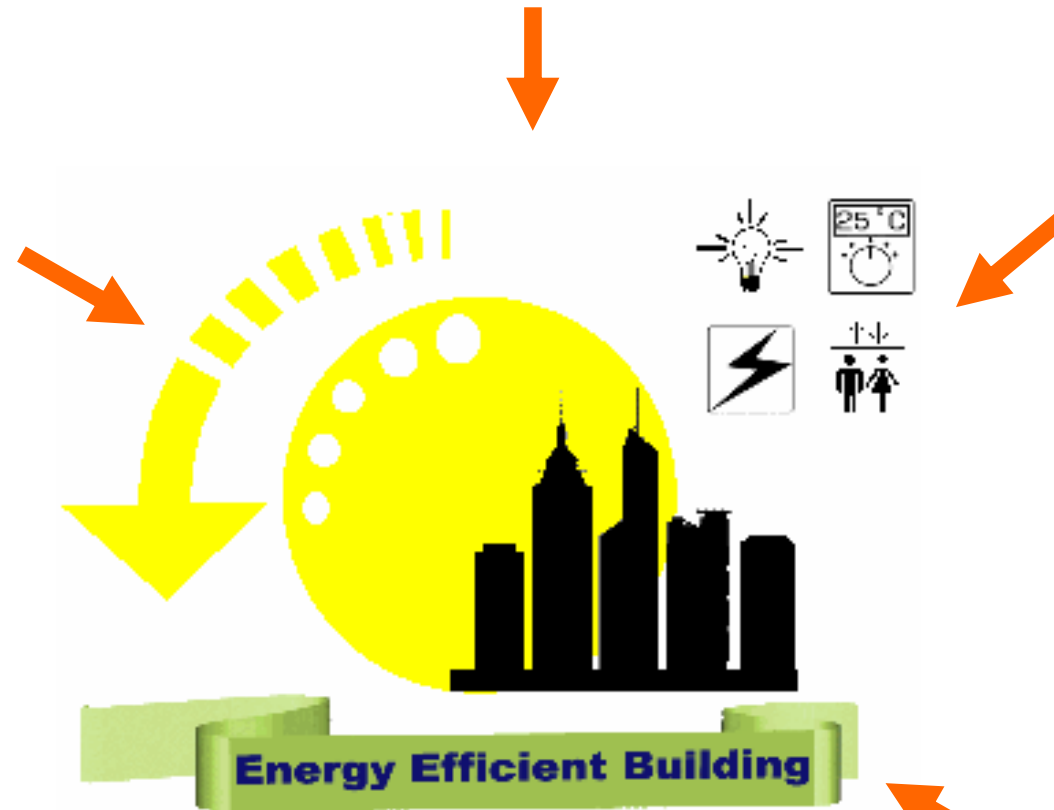
- For new buildings
 - Designing the building
 - Design strategy
 - Control strategies
 - Commissioning
- For existing buildings
 - Operating and upgrading the building
 - Building management
 - Refurbishment/renovation/retrofitting
 - Maintenance and monitoring



Good design practices

Integrated & total energy approach

Efficient systems



Good house-keeping

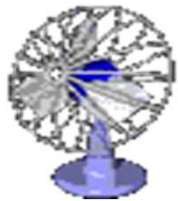
User education & awareness

Efficient operation

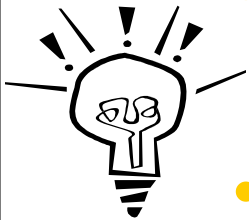


Energy efficiency

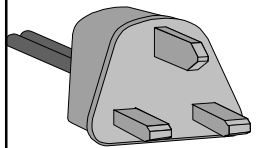
- Design strategies:



- Minimise thermal loads & energy requirements
 - e.g. by reducing heat gains from equipment



- Optimise window design & fabric thermal storage
 - Integrate architectural & engineering design



- Promote efficiency in building services systems
 - Use of heat recovery & free cooling methods
 - Energy efficient lighting design & control
 - High-efficiency mechanical & electrical systems

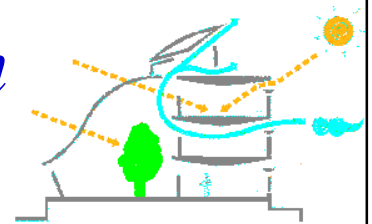


- Adopt total energy approach (e.g. district cooling, combined heat & power)



Energy efficiency

- Promote *passive design* and *natural ventilation*
 - e.g. bioclimatic buildings, passive cooling/heating
- Adopt energy efficient *building services systems*
 - Lighting, air-conditioning, electrical, lifts
- Study and optimise *thermal & energy performance*
 - e.g. by computer simulation or energy audit
- Must also ensure *efficient operation and management* of the building
 - User education & awareness, good housekeeping





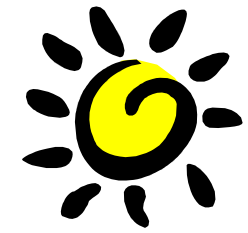
Energy efficiency

- Video: **Energy 101: Energy Efficient Commercial Buildings** (4:19)



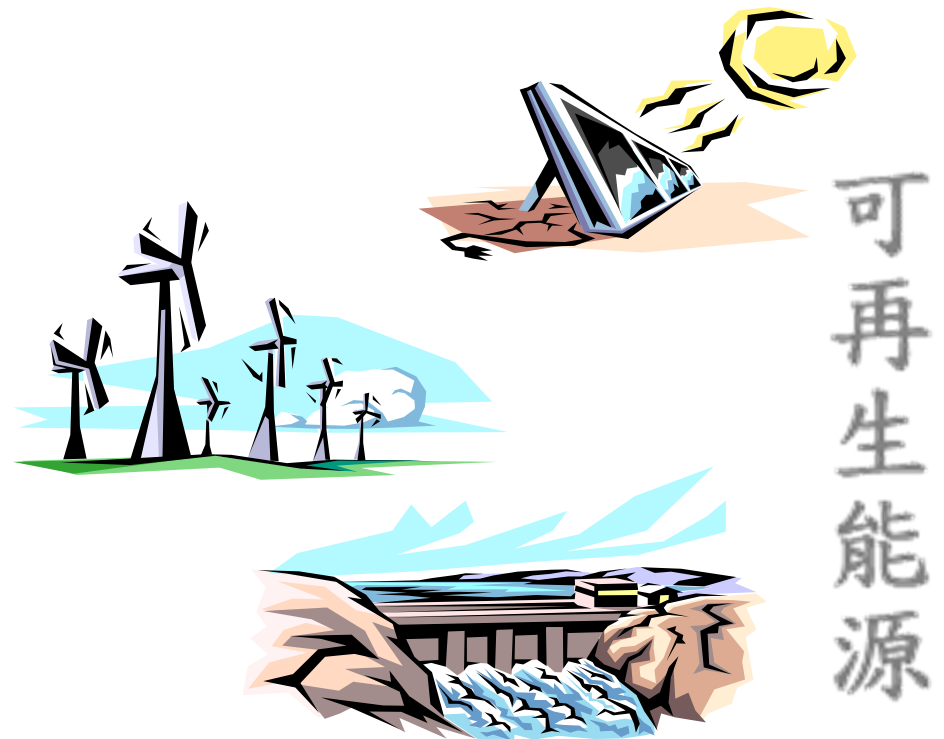
- <http://youtu.be/5VMXL31EYTI>

- Learn how commercial buildings can incorporate whole-building design to save energy and money while enhancing performance and comfort.
- This video highlights several energy-saving features of the Research Support Facility at the Energy Department's National Renewable Energy Laboratory—a model for high-performance office building design.



Renewable energy

- Energy that occurs naturally and repeatedly on earth and can be harnessed for human benefit, e.g. solar, wind and biomass
- Common applications
 - Solar hot water
 - Solar photovoltaic
 - Wind energy
 - Geothermal
 - Small hydros



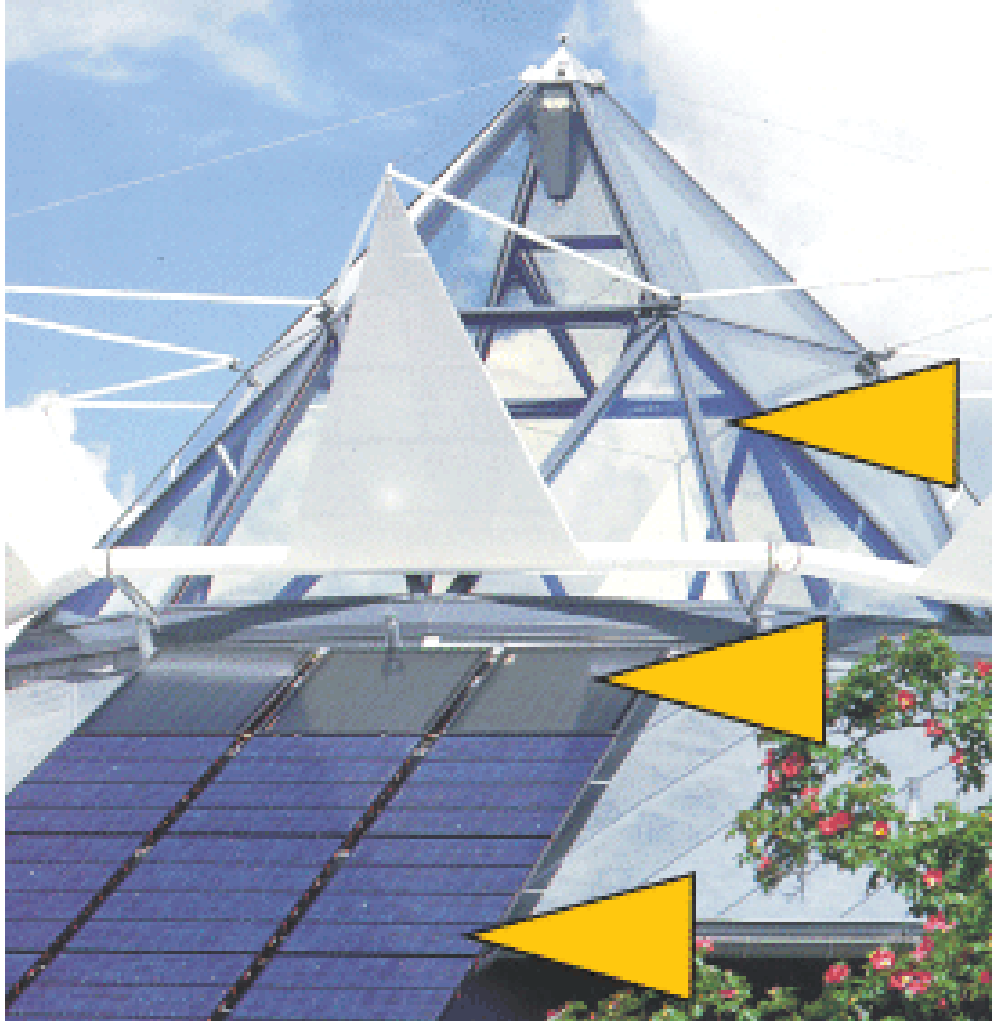
Renewable energy



- Renewables for buildings
 - Solar energy
 - Passive (low energy architecture)
 - Active (solar thermal)
 - Photovoltaics
 - Other renewables
 - Wind (using buildings to harvest wind energy)
 - Geothermal (e.g. hot springs)
 - Small hydros (e.g. water wheels)
 - Hybrid systems (e.g. PV + wind + diesel)

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Integration of solar energy systems in buildings



Passive solar (e.g. skylight)

Active solar (solar hot water)

Photovoltaics

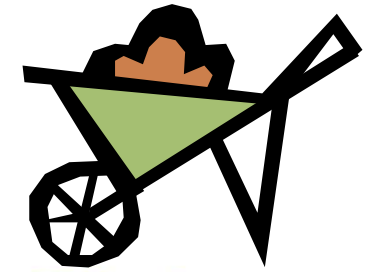
Innovative ideas for building integrated renewable energy



Dutch pavilion,
EXPO 2000 Hannover

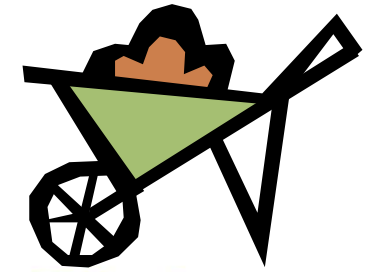


Project Zed - London



Building materials

- Environmental impact of building materials
 - Through consumption of resources
 - Through production of resources (by-products, wastes, pollution, recyclables)
- Objectives
 - Make informed environmental choices about building materials and systems
 - Careful design & understanding about materials

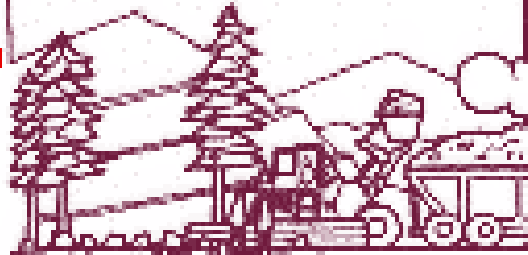


Building materials

- What makes a product **green**?
 - Measured by their environmental impact
 - Life cycle of a sustainable material
 - Using local, durable materials
- Embodied energy*
 - ‘Lifetime’ energy requirement of a material
 - Energy input required to quarry, transport and manufacture the material, plus the energy used in the construction process

[* http://en.wikipedia.org/wiki/Embodied_energy]

Resource Extraction



Manufacturing

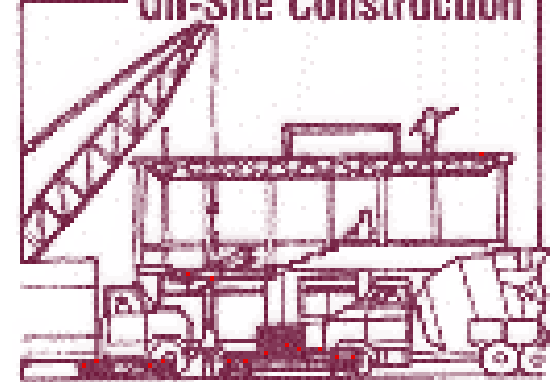


Recycling/Reuse/Disposal

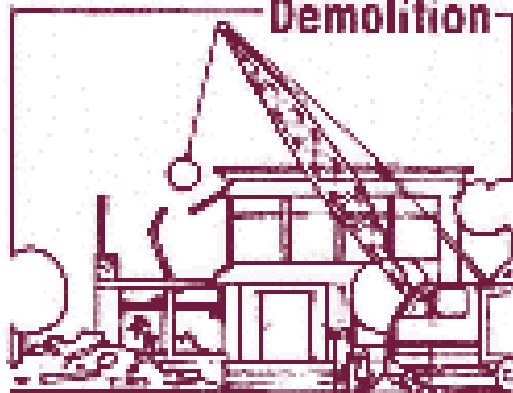


Life Cycle of Building Products

On-Site Construction



Demolition



Occupancy/Maintenance



Green Features

**Manufacturing
Process (MP)**

**Building
Operations (BO)**

**Waste
Mgmt. (WM)**

Waste
Reduction (**WR**)

Pollution
Prevention (**P2**)

Recycled (**RC**)

Embodied Energy
Reduction (**EER**)

Natural
Materials (**NM**)

Energy
Efficiency (**EE**)

Water Treatment &
Conservation (**WTC**)

Nontoxic (**NT**)

Renewable Energy
Source (**RES**)

Longer Life
(**LL**)

Biodegradable
(**B**)

Recyclable
(**R**)

Reusable (**RU**)

Others (**O**)

Water issues

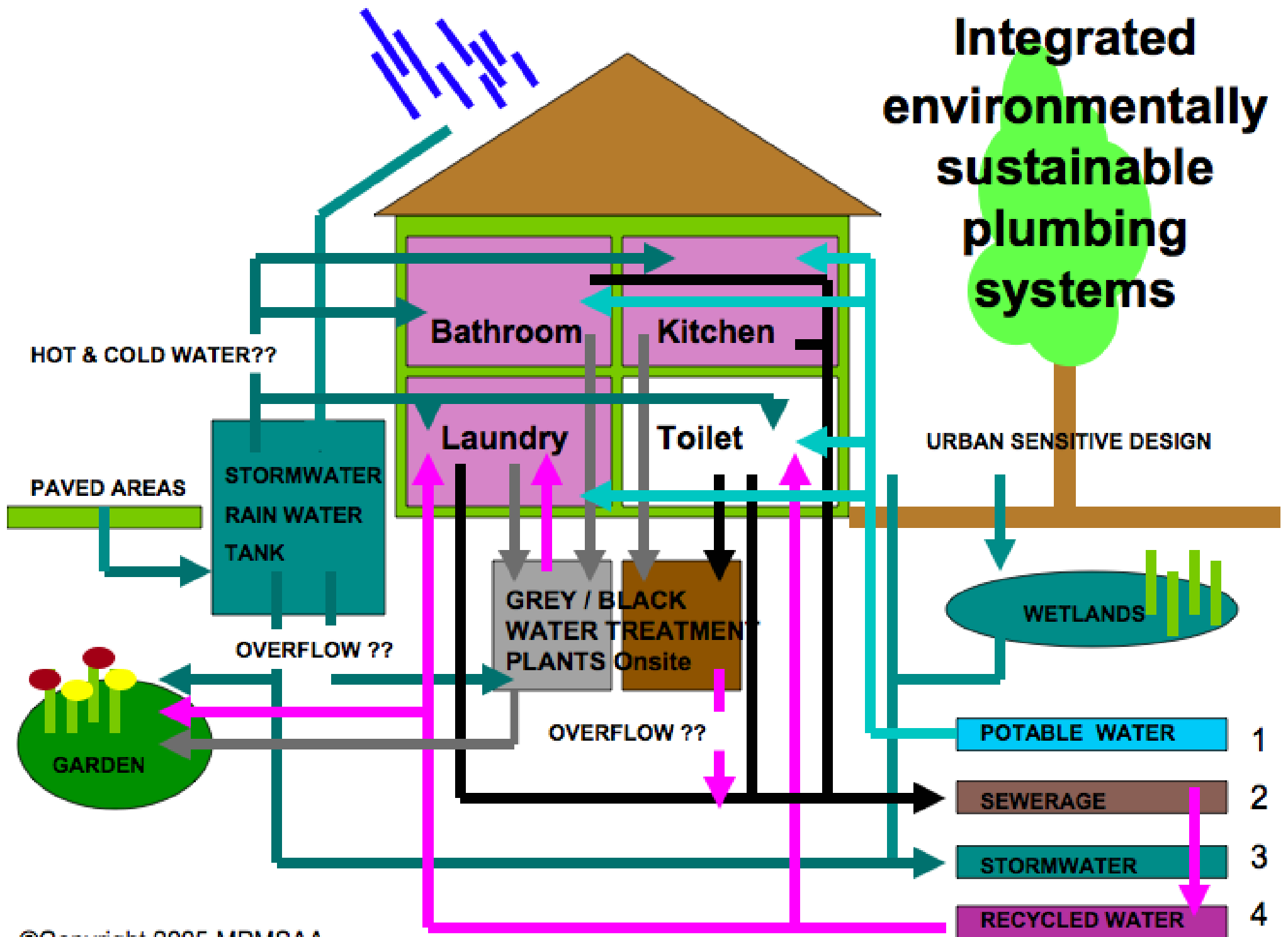


- Stormwater or watershed protection
 - Control rainwater runoff, flooding and erosion
 - Preservation of soils and drainage ways
 - Porous paving materials
 - Drainage of concentrated runoff
 - Avoid pollution and soil disturbance
- Water efficiency and conservation
 - Saving of water and money: water-use charge, sewage treatment costs, energy use, chemical use



>>> Make the best use of water resources.

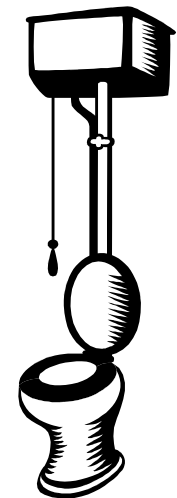
Integrated environmentally sustainable plumbing systems



Water issues

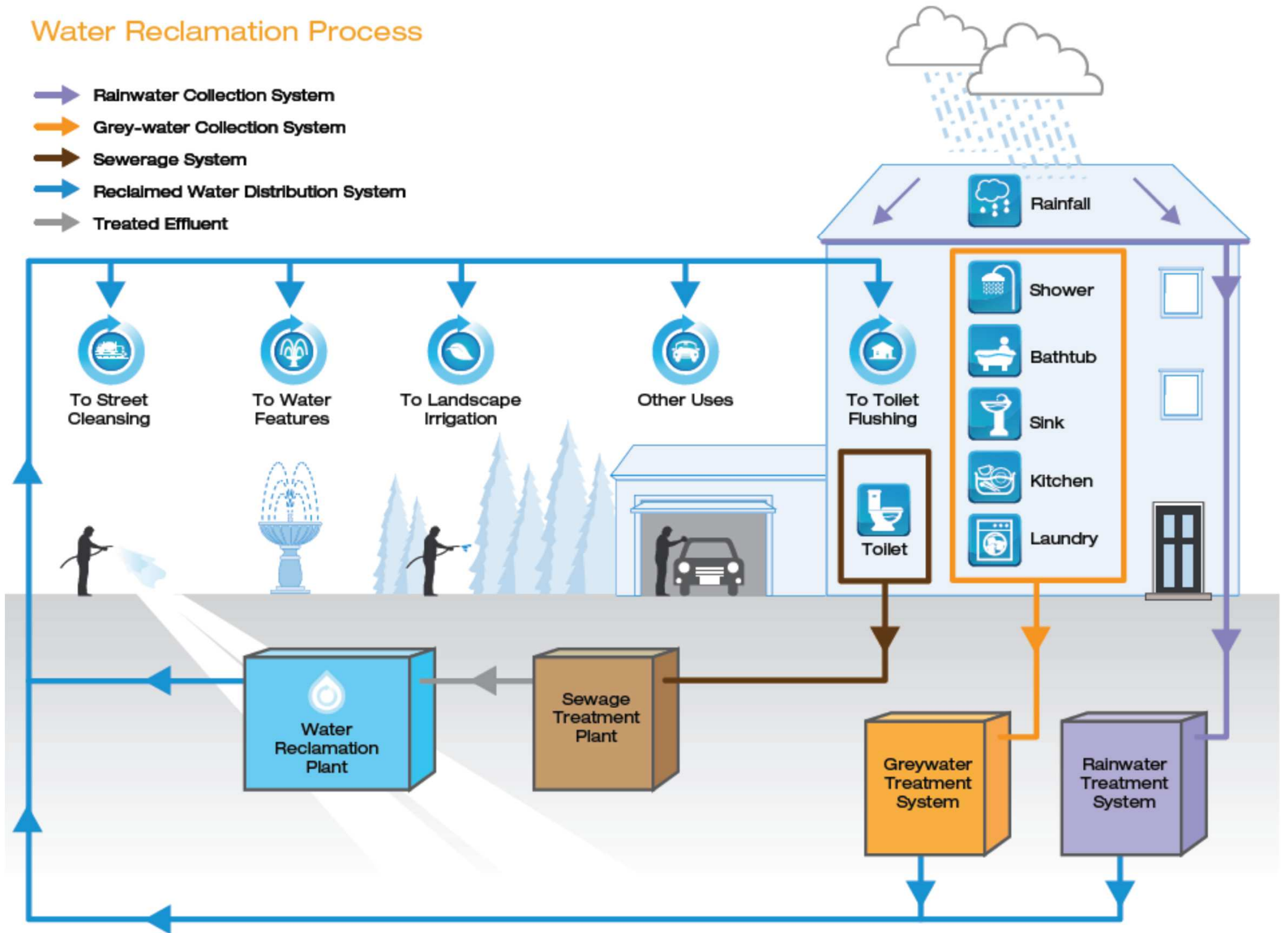


- Design strategy for water efficiency
 - Reduce water consumption
 - Low-flush toilets & showerheads
 - Leak detection & prevention
 - Correct use of appliances (e.g. washing machine)
 - Reuse and recycle water onsite
 - Rainwater collection & recycling
 - Greywater recycling (e.g. for irrigation)
 - No-/Low-water composting toilet



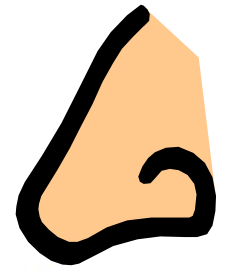
Water Reclamation Process

- ➔ Rainwater Collection System
- ➔ Grey-water Collection System
- ➔ Sewerage System
- ➔ Reclaimed Water Distribution System
- ➔ Treated Effluent



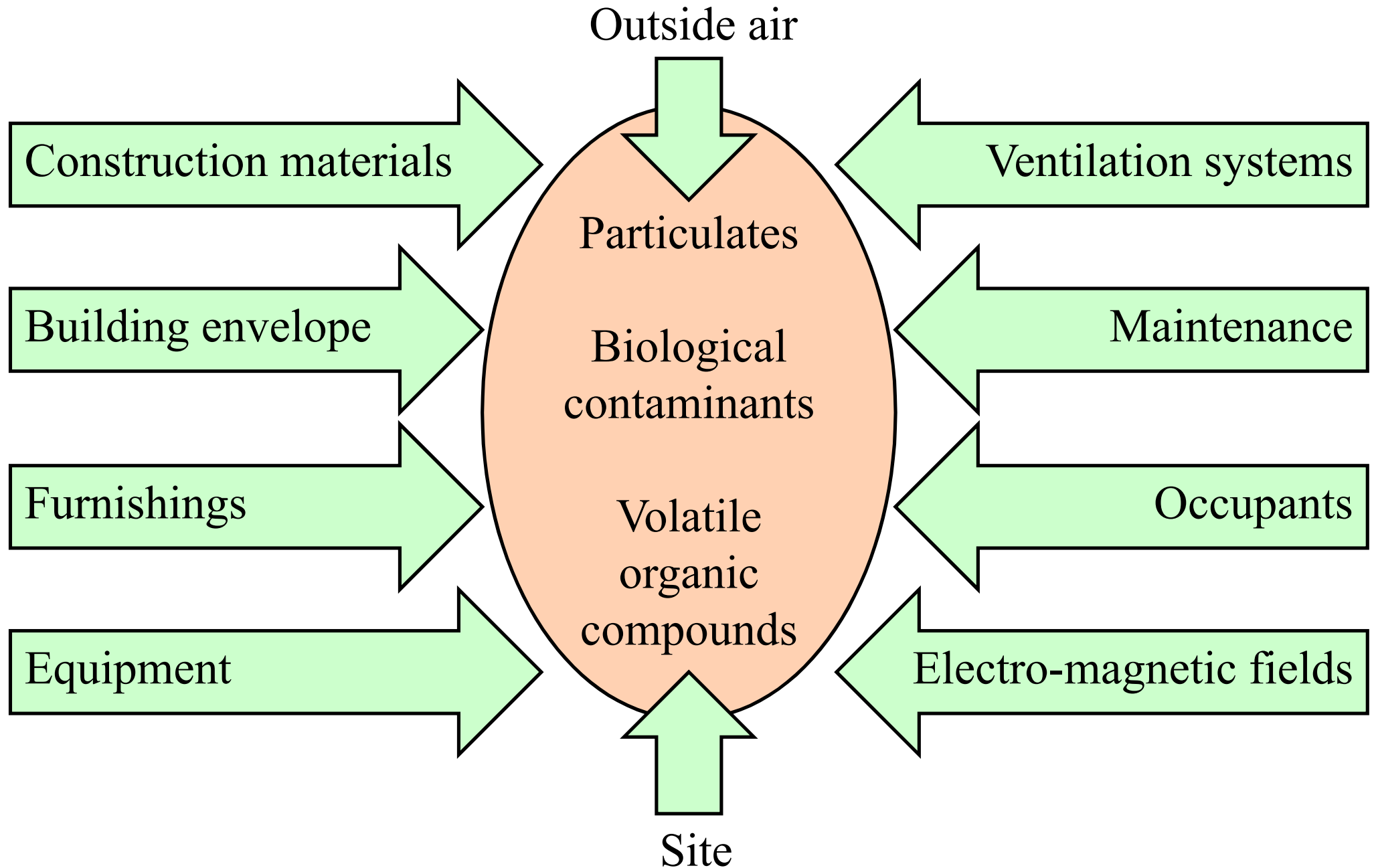
(Source: Water Supplies Department, www.wsd.gov.hk)

Indoor environment



- Indoor environmental quality (IEQ)
 - Indoor air quality
 - Ensure health & well-being
 - Visual quality
 - Provide daylight & comfortable conditions
 - Acoustic quality
 - Noise control
 - Controllability
 - Allow occupant control over thermal & visual

Major factors contributing to indoor air quality (IAQ)



Four principles of indoor air quality design

1. Source Control

+

2. Ventilation Control

+

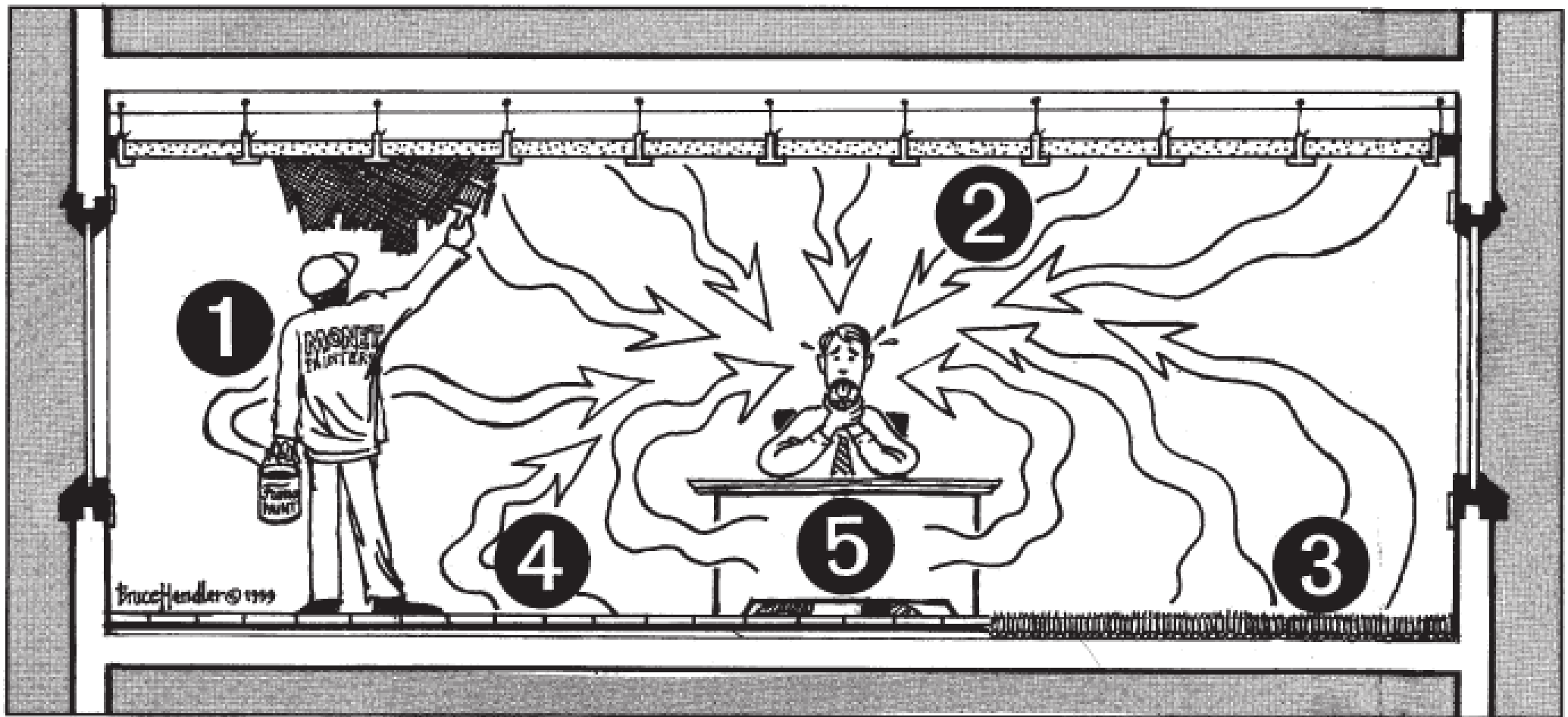
3. Occupant Activity Control

+

4. Building Maintenance

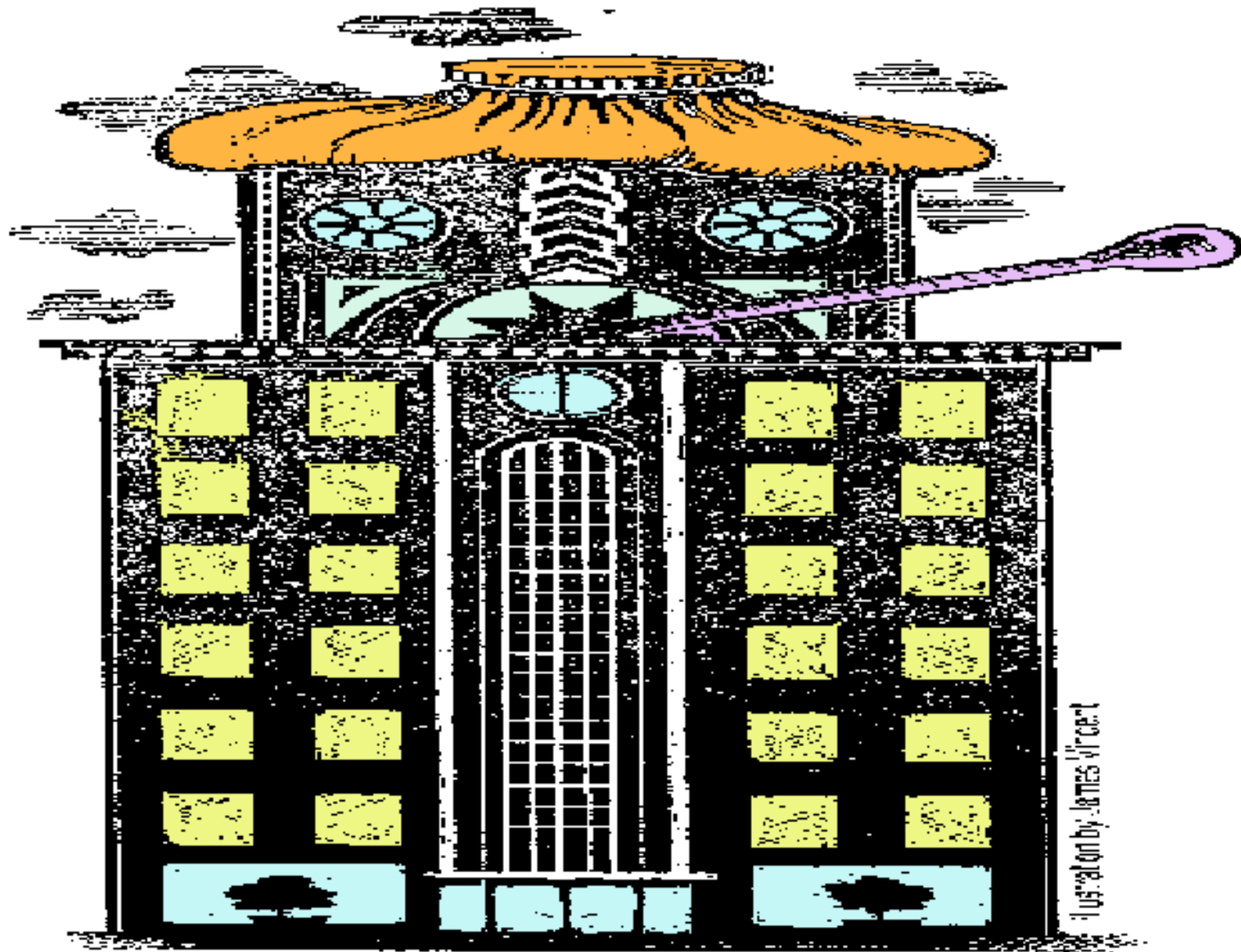
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*Total
Indoor
Air
Quality*

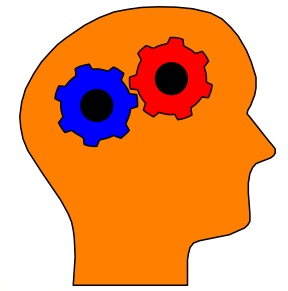


Sources of offgassing in building materials:

- 1) paints,
- 2) ceiling tiles,
- 3) carpeting,
- 4) VCT floor tiles
- 5) manufactured wood products



Avoid “sick building syndromes” by maintaining good indoor air quality



Integrated building design

- WBDG - The Whole Building Design Guide
 - http://www.wbdg.org/design/engage_process.php
- Two components of whole building design:
 - Integrated design approach
 - Integrated team process
- A holistic design philosophy
 - Holism + Interconnectedness + Synergy
 - *“The whole is greater than the sum of its parts”*





Emphasize the *integrated process*

Ensure *requirements and goals are met* (via Building Commissioning, etc.)

Think of the building as a *whole*

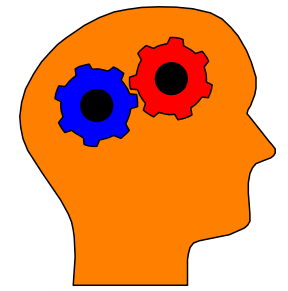
Evaluate solutions

Focus on *life cycle design*

Develop *tailored solutions* that yield multiple benefits while meeting requirements & goals

Work together as a *team* from the beginning

Conduct *assessments* (e.g., Threat/Vulnerability Assessments & Risk Analysis) to help identify requirements & set goals

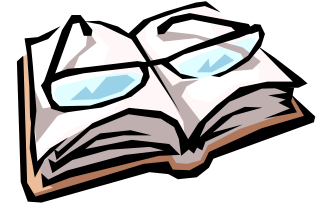


Integrated building design

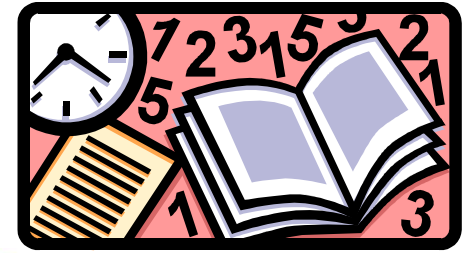
- Typical integrated design process
 - Preparation
 - Design development
 - Contract documents
 - Construction phase
 - Commissioning
 - Post-occupancy evaluation
- Usually more efforts in preparation and pre-design phases



Further reading



- Green building design strategies
 - [http://ibse.hk/GB design strategies.pdf](http://ibse.hk/GB_design_strategies.pdf)
- Whole Building Design Guide (WBDG)
 - Sustainable, www.wbdg.org/design/sustainable.php
- HK Green Building Technology Net
 - <http://gbtech.emsd.gov.hk>



References

- Brophy, V. and Lewis, J. O., 2011. *A Green Vitruvius: Principles and Practice of Sustainable Architectural Design*, 2nd ed., Earthscan, London.
 - <http://books.google.com.hk/books?id=uPvajUb2C04C>
- PTI, 1996. *Sustainable Building Technical Manual: Green Building Design, Construction and Operations*, Public Technology, Inc. (PTI), Washington, D.C.
 - <http://smartenergy.illinois.edu/pdf/archive/sustainablebuildingtechmanual.pdf>